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Nonproliferation and the Global Nuclear Energy Partnership (GNEP)

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Abstract

The Bush Administration announced in 2006 a new Global Nuclear Energy Partnership (GNEP) that seeks to increase U.S. and global energy security and promote nonproliferation through the expanded use of proliferation-resistant nuclear energy to meet growing electricity demand. The key elements of GNEP include the expansion of domestic use of nuclear power; demonstration of proliferation-resistant recycling; the minimization of nuclear waste; the development of advanced burner reactors; the establishment of reliable global fuel services; the demonstration of small- and medium-scale, proliferation-resistant reactors; and the revitalization of programs for advanced nuclear safeguards. If it succeeds, the partnership would demonstrate the critical technologies needed to change the way spent nuclear fuel is managed. National and international acceptance of GNEP, as well as its success, will depend in large part on early demonstration of the technical nonproliferation elements, including advanced safeguards and proliferation resistance, of all GNEP fuel cycle elements. An enhanced, systematic, defense-in-depth approach to nonproliferation that acknowledges the changing threat space, along with the new technological possibilities opened by GNEP, is essential. The prospects for GNEP are also dependent on developments in the wider nonproliferation arena, including initiatives to

[1] The views expressed are the author's own and not those of the Los Alamos National Laboratory, the National Nuclear Security Administration or the Department of Energy.

strengthen the nonproliferation regime being pursued by the United States, the International Atomic Energy Agency, the Nuclear Suppliers Group and the Group of Eight. This paper will assess the importance of the nonproliferation elements of GNEP, the nonproliferation challenges that might arise during efforts to transition to the GNEP vision and the technological requirements for meeting those challenges.

Introduction/Background

As part of President Bush's Advanced Energy Initiative, the Bush Administration has announced a new Global Nuclear Energy Partnership (GNEP) that seeks to increase U.S. and global energy security and promote nonproliferation through the expanded use of proliferation-resistant nuclear energy to meet growing electricity demand. The key elements of GNEP include the expansion of domestic use of nuclear power; demonstration of proliferation-resistant recycling; the minimization of nuclear waste; the development of advanced burner reactors; the establishment of reliable global fuel services; the demonstration of small- and medium-scale, proliferation-resistant reactors; and the revitalization of programs for advanced nuclear safeguards.

The closed fuel cycle model envisioned by this partnership requires development and deployment of technologies that enable recycling and consumption of long-lived radionuclides in radioactive waste. More specifically, GNEP would achieve its goals by:

- having nations with secure, advanced nuclear capabilities provide fuel services — assured supply of fresh fuel and the disposition of spent fuel — to other nations who agree to forgo enrichment and reprocessing activities;
- demonstrating the critical technologies needed to change the way spent nuclear fuel is managed; and
- building recycling technologies that enhance energy security in a safe and environmentally responsible manner, while promoting nonproliferation.

This paper will assess the importance of the nonproliferation elements of GNEP, the nonproliferation challenges that might arise during efforts to transition to the GNEP vision and the technological requirements for meeting those challenges.

The GNEP Nonproliferation Vision

It might be argued that because recycling technology and advanced burner reactors will be limited to either nuclear-weapon states (NWSs) or to other states with advanced fuel cycles, that nonproliferation and safeguards are irrelevant and that those GNEP elements that referred to nonproliferation were unnecessary. This would be erroneous, as it does not take into consideration such factors as domestic and international public acceptance, the importance of transparency for the states with these facilities, the long-term risks posed by states that might not accept GNEP and by nonstate actors, etc.

Nonproliferation is important to GNEP. The partnership offers a bold, comprehensive vision of the future of nuclear energy that seeks to address the challenges posed by a number of the most pressing of today's proliferation problems. It attempts to address the spread of sensitive nuclear technology and the concerns posed by vast stockpiles of separated plutonium, as well as to meet the nonproliferation demands of a global nuclear energy renaissance.

If GNEP succeeds as planned, significant nonproliferation benefits could be expected, including:

- Slowing, if not halting, the spread of enrichment and reprocessing (ENR) technologies;
- Creating a fully functioning, effective and nondiscriminatory assured fuel supply/takeback regime that should facilitate the political acceptance of ENR limitations;
- Limiting inventories of separated weapon-usable material and ensuring that they are rigorously safeguarded, protected and accounted for;
- Slowing, if not halting, further production of separated plutonium, as new recycling technologies will allow the burning of plutonium in fast spectrum reactors without ever having separated it from other actinides; and
- Minimizing and disposing of waste, reducing potentially attractive targets for terrorists.

In this world, even if there were near-universal buy in for GNEP by states, there would continue to be proliferation problems and risks. There would be growing requirements as a result of take back to move spent fuel around the world, increasing transportation risks to some degree. At least some states could be expected to develop or expand virtual capabilities through their fuel-cycle choices, creating the prospect of a breakout. Finally, states with clandestine programs will remain a possible threat, as will nonstate actors seeking nuclear and radiological weapons. These issues they must be seen in perspective. They will appear and need to be addressed to some degree with or without GNEP, but they cannot be ignored and must be considered in the GNEP calculus.

Beyond any such risks, it must be recognized that GNEP technology, and the nonproliferation approaches surrounding it, including advanced safeguards and proliferation resistance, will need to be fully demonstrated.

Nonproliferation Elements in GNEP

Given the importance of nonproliferation to GNEP, a key lynchpin for realizing the GNEP is development of a next-generation nonproliferation system, including advanced safeguards and proliferation resistance.

Advanced Safeguards for GNEP Facilities

There is little doubt safeguards will need to evolve in the future, as they largely have over the last decades. GNEP can be a critical impetus for the evolutionary path to proceed. GNEP offers an opportunity to design an effective, integrated global safeguards system.

Advanced safeguards development and implementation is a key component of the partnership. A central need, recognized in GNEP, is cooperation with partners and the International Atomic Energy Agency (IAEA) a defense-in-depth safeguards approach to GNEP. This will involve, inter alia:

- threat assessments;
- integrated, advanced safeguards systems;
- integration of safeguards and security systems in the early design phase;
- tailored fuel-cycle development to facilitate safeguardability (e.g., fuel design); and
- modeling and simulation.

More specifically, elements of defense-in-depth could include, inter alia:

- state-of-the-art instrumentation and methodologies for materials measurement and accounting, including sensor platform integration;
- enhanced containment and surveillance, including portal and area radiation monitoring;
- integration of access denial and transparency elements of physical protection and safeguards; and
- integration of traditional process monitoring with non-traditional indicators, such as detection of radiation signals where they should not be, questionable movement of equipment and people, etc.

The advanced safeguards technologies for GNEP and other future needs will require a serious investment in research and development and advanced safeguards concept demonstrations, including the following:

- state-of-the-art instrumentation and methodologies for materials measurement;
- advanced process monitoring, including in-line process monitoring to detect diversion;
- use of operational and safety information through sharing and authentication of the operator's data;
- near real-time accounting and in-line evaluation of the effectiveness of safeguards measures;
- process simulation and modeling to optimize safeguards; and
- intrinsic transparency in facility operations.

Each of the GNEP construction projects represents an opportunity to demonstrate not only advanced fuel cycle techniques and processes but also new safeguards elements and approaches. As the experience at Rokkosho shows, early consideration of safeguards in all stages of facility design is critical. Recycling spent fuel and fabrication of transuranics require automated processes; it will be difficult and costly to retrofit safeguards after the fact.

The effort outlined above should meet emerging needs and represents a possible point-of-departure for process changes and safeguards improvements as nuclear power expands. If they succeed, they will show that GNEP can foster nonproliferation, and substantially improve the future nonproliferation environment. It will be important to understand this to the extent possible during the demonstration phase; it is not too early to begin thinking about future authorities as well as technologies needed to implement them.

GNEP and Proliferation Resistance

Although there is no consensus on the meaning of proliferation resistance, it is seen to involve both intrinsic (technological) and extrinsic (institutional) factors. No separations process can be inherently proliferation resistant, and ultimately safeguardability along with extrinsic factors are central to achieving proliferation resistance. Foe GNEP, an important aspect of proliferation resistance involves its approach to dealing with plutonium.

GNEP looks to reduce the risks of a closed fuel cycle by developing and deploying new technologies to recycle spent nuclear fuel without separating pure plutonium. It envisions development and deployment of advanced burner reactors to minimize nuclear waste as well as produce energy from recycled nuclear fuel. If widely adopted, GNEP would limit the generation of stocks of separated plutonium around the world and, in the long term, offer a path to reducing existing stocks. To the extent these goals are realized, GNEP would offer improvements over the PUREX fuel cycle as utilized around the world.

More specifically, GNEP demonstration plans include UREX + processing of spent fuel with new fuel fabrication and actinide burning. UREX + would do group separation of actinides, keeping the long-lived actinides with the plutonium and burn them in fast reactors. The UREX + intermediate product, i.e., plutonium along with higher actinides is not as self-protecting as spent fuel. However, it will be hotter than separated reactor-grade plutonium, under tight safeguards and security and less attractive and practical for a proliferant state seeking its own nuclear weapons than separated plutonium. The vulnerability to possible terrorist theft is limited, and can be further reduced by modifications to the material or to the facility design.

Strengthening the Nonproliferation/Security Environment

Beyond these direct nonproliferation needs outlined, in part, in the GNEP announcement and subsequent plans, other elements of US and international nonproliferation efforts will reinforce and be reinforced by GNEP, including increased support for the Treaty on the Nonproliferation of Nuclear Weapons (NPT), the Nuclear Suppliers Group (NSG), the International Atomic Energy Agency and other nonproliferation initiatives.

There are technological challenges in these areas, as in the area of safeguards at declared facilities. In this context, several relevant areas are discussed below.

Improved Detection of Clandestine Facilities/Activities

Although GNEP calls for advanced safeguards at declared fuel cycle facilities, it does not explicitly address undeclared facilities and activities. Nonetheless, widespread undeclared capabilities would undermine the vision and needs to be addressed.

The IAEA is charged with detection of clandestine facilities and activities, a mission previously limited in practice to a few national intelligence agencies. For the Agency, the tools in the Additional Protocol, including enhances information analysis and complementary access, are central. But there is a need to develop new technical detection capabilities. This will require further work to identify technological gaps, especially with respect to detecting clandestine enrichment, and ensure they are filled to the extent possible. To do so will require in turn a significant R&D investment and strategic planning and cooperation between the Agency and member states.

Nuclear Material Control, Tracking and Forensics

The ability to accurately control, to track and to make definitive identification of material in use within facilities, in storage/disposal or in transit would greatly facilitate GNEP's objectives as well as other US and international nonproliferation and counterterrorism goals. To begin, pursuing global best practices on security, Material Protection, Control & Accountancy (MPC&A), etc., will be critical. This is an effort that can build off of US-Russian cooperation, US-IAEA interactions and other ongoing relationships. But new capabilities are needed. Some of these capabilities would be captured through advanced safeguards R&D, including enhanced process monitoring. However, there are needs that go beyond safeguards and they must be addressed as well.

NSG/Export Control Technical Support

The importance of export controls remains central even though the UREX + plants and advanced burner reactors envisioned initially under GNEP would not be widely exported, if at all. Key export control considerations include enhanced trigger list and dual-use controls in the context of requiring more stringent conditions for exports. One concrete activity for the NSG and the Zangger Committee to engage in could be technical trigger list clarification exercises on advanced burner reactors, related fuel fabrication technologies and UREX+ and related reprocessing technologies.

Development of Proliferation-Resistant Reactors

A key element of GNEP—one being pursued outside of GNEP as well—is the development of proliferation-resistant, safeguardable reactors for export. More rigorous assessments of the features of next-generation reactors and analyses of the costs and benefits of retrofitting existing reactors where feasible are necessary. A fundamental need is the development of international standards.

As part of this activity, it will be essential to understand better and to address the safeguards challenges of new reactor concepts, including assessing whether small- and medium-scale reactors designed to meet the energy needs of developing states are sufficiently proliferation resistant and, if needed, developing approaches to safeguarding these reactors.

Summary/Conclusions

Not only GNEP's acceptance, but its success, depends on early demonstration of the nonproliferation elements of, and approaches to, all GNEP closed fuel cycle elements.

Moreover, it is clear that the broader nonproliferation/counterterrorism environment needs to be addressed if the objectives of GNEP are to be realized fully. In this context, many of the steps that should be taken during the transition to GNEP—which will likely last decades—are already being proposed or pursued as part of the current nonproliferation initiatives of the United States, the International Atomic Energy Agency and others. These efforts are critical to the success of GNEP; they also remain highly valuable in their own right. If GNEP is to be successful, it will build on and advance these and other US and international nonproliferation objectives.